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Working Paper Series

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Technology Transfer Offices (TTO) in Italian universities: What they do and how they do it

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WP-2005/5

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1. Introduction

The contribution of the knowledge producing sector to the innovative activity of firms, and to economic development in general is widely recognised. Nevertheless, several new important subtopics have emerged during the last two decades, which represent increasingly important research issues for academics and policy makers.

The undisputed importance of scientific and technological knowledge finds no unanimously accepted policy and strategy recipes in either industry or academy. With regard to academic and public research activities, beyond basic acquisitions and policy objectives such as "more financial resources for the knowledge producing sector", which sounds more than reasonable in today's knowledge-based economies, many other questions arise. For example, should we have more basic research, or rather more development and technology transfer programmes? Should central governments promote a further concentration of resources in a relatively limited number of research centres or should they make efforts to raise the average qualitative level of research centres at national level? And what about companies which finance R&D staying "on campus", with direct involvement in defining academic research topics? And those which (patiently) wait "out of the campus", trying to use the results of public research without looking for ant priority advantages based on Intellectual Property Rights (IPRs)? Should universities be aware of industrial and societal needs, and even be involved in protecting research results and selling property rights before publishing on scientific journals, or should they rather be worried about protecting their freedom of research, in order to promote long-term, potentially breakthrough, not necessarily "direclty useful" research paths?

The debate concerning the long-term mission of universities and publicly-funded research organisations (Public Research Organizations - PROs) regards these issues. Similarly to companies, universities worldwide have been progressively pervaded by a new culture, which originated first in the US, then in the UK, and finally reached the rest of Europe and spread worldwide. It is well known that American universities differ greatly from European ones because of their different origins (Rosenberg and Nelson, 1994; Geuna, 1999), and at present represent places where talented researchers are keen to establish their laboratories, whichever their country of origin, thanks to research infrastructures, availability of young assistants, possibility to attract the interest of investors. Nevertheless, the fairly new fact is that both in the US and in several other countries in the world, universities and PROs have started to play a more "entrepreneurial" role (Clark, 1998; Etzkowitz et al., 2000). They are more and more engaged in starting new companies, providing training to private companies, paying more attention to regional economic development, managing incubators, science parks and even their own venture capital companies. All this represents a new set of activities for them.

Among other issues, dealing with patenting activity and with the creation of spin-off companies – often within Technology Transfer Offices (TTOs) – is part of this broad evolution, and it is the topic of this paper. The correct understanding of the evolution of PROs' aptitude concerning patents and spin-offs, and the motivations behind the creation of new TTOs is a key aspect not only for policy makers, but also for the industrial sector. The reason is twofold. First, from a macro-economic perspective, public research organisations represent the main producer of scientific and technological knowledge in modern economies. The way in which these organisations deploy and exploit the results of

their research activity directly influences the extent and the mechanisms of knowledge diffusion and transfer. Since firms' innovative efforts are strictly linked to external sources of knowledge (universities and other research institutions), a change in the knowledge diffusion mechanisms will directly influence firms' competitiveness and productivity.

Second, from a micro-economic perspective, the exploitation strategies set-up by PROs directly influence the procedures of interaction between university and industry. If PROs decide to patent (and subsequently license) most of their research results, or if they decide to exploit those results by creating a new spin-off company, firms will then face potential partners that have quite radically modified their objectives and behaviour. University-industry collaborations will have to be established upon new (and partly to be defined) bases, and firms will have to adapt to this new model.

The literature has already explored several dimensions of this process (among others, see Geuna, 1999; Dodgson, 1993; Gibbons *et al.*, 1994; Lowe, 1993; Mansfield and Lee, 1996; Muster, 1995; Piccaluga, 1992; Roberts, 1991; Stajano, 1999). For instance, it has been well documented that the main factors that have favoured this trend can be identified in the decrease and change of funding sources for universities, in the increasing autonomy of universities, in the increasing pressure for universities in being directly active in regional development processes, in the "scientification" of production processes. Also, there is some evidence about the mechanisms through which research results are exploited, either by means of patents and licenses, or the creation of new high-tech companies (spin-offs). However, only a few studies (Siegel *et al.*, 2004; Clarysse *et al.*, 2004) offer insights into the (human and financial) resources that the universities devote to this purpose, and on the formal solutions they adopt (industrial liaison offices, technology transfer offices, patent offices, and so on).

This paper goes along this direction and explores the role of Italian universities in the commercialisation of the results of their research activity. By means of a survey conducted to collect data about fiscal year 2002 and 2003, to which a total of 33 different Technology Transfer Offices belonging to Italian universities participated (29 for year 2002 and 26 for year 2003), we assess the motivations and goals of these institutions, the resources they devote to the transfer activities, the results obtained and costs sustained for the promotion of this activity. Specifically, we look at how Italian universities manage intellectual property (IP) and know-how produced from academic research and its commercialisation through licensing and the creation of new spin-off companies. Further, we analyse some relevant case studies, in order to complement quantitative information with a qualitative assessment of the procedures and strategies implemented by the Italian academic institutions.

The paper is organised as follows. In Section 2 we present a brief description of the Italian innovative system, which affects the role of universities, and the effectiveness of the technology transfer activities. Section 3 presents the results of our survey on the universe of university TTOs currently operating in Italy, and assesses both the differences among them, and the evolution of their activity over the last two years. In order to better characterise existing differences among TTOs, in Section 4 we present a brief description of two (extreme) cases, with regard to their motivations, organisations, activities and outcomes. Finally, Section 5 concludes the paper.

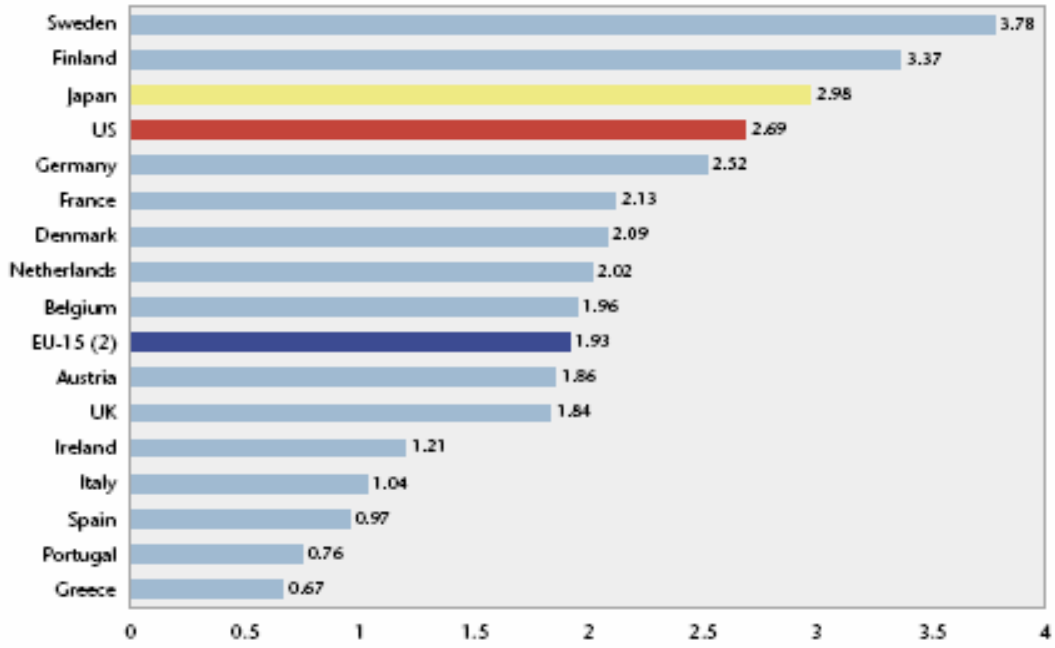
2. Technology transfer in Italian universities

The traditional National Systems of Innovation approach (Nelson, 1993; Porter, 1990) has clearly emphasized that a country's research and innovative performance is influenced by the characteristics of the institutions which are active both at the supply and demand sides (research institutions, and firms) of the country itself. Similarly, it can be argued that technology transfer activity of Italian universities is strongly influenced by the characteristics of the Italian system of innovation, both in terms of supply and demand conditions. On the one hand, the quantity and quality of research results available and potentially ready to be transferred to industrial partners depend on the resources that the Italian system on the whole devotes to research activity performed by academic institutions. On the other hand, university research is influenced by the demand of technology by the industrial sector (Rosenberg, 1982), and hence by the characteristics of the industrial structure.

Regarding both dimensions, however, Italian conditions seem particularly weak in comparison with other European and non-European countries. Specifically:

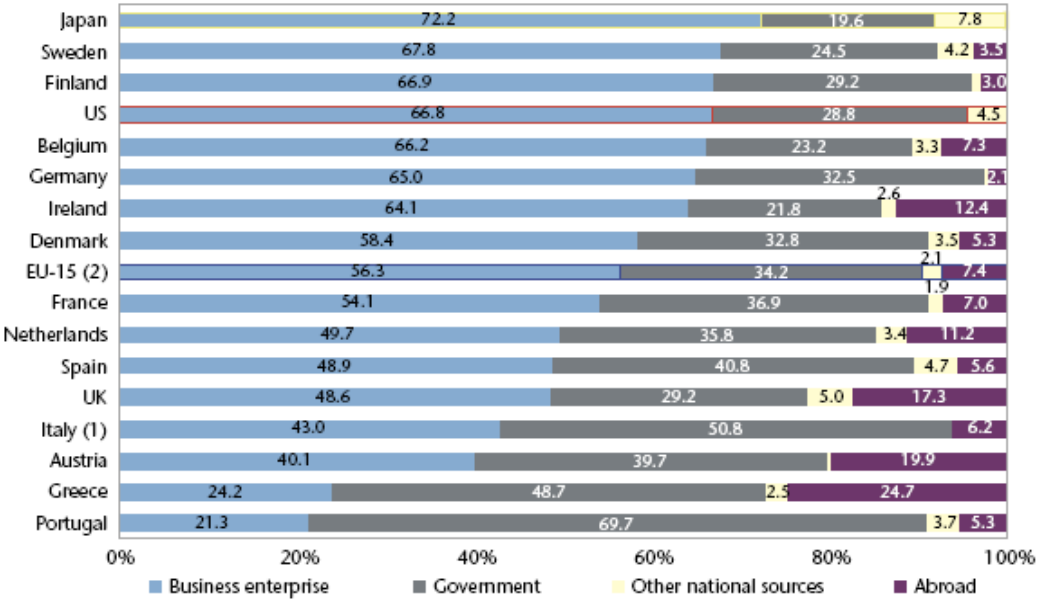
- among European countries, and compared to Japan and the US, the share of GDP that Italy devotes to R&D expenses is traditionally very low, and almost declining steadily over time. As Figure 1 shows, Italian R&D intensity is about one half of the European average, and directly comparable to countries like Spain and Ireland. Japan and Northern European countries spend in R&D three times more than Italy;
- The lower propensity to spend in R&D is mainly due to the marginal role played by Italian industrial institutions. If the total level of R&D expenditure is subdidived in terms of sources of financing, it emerges that the industrial sector participates with a share which is lower than that of both the US and Japan, and the European average (Figure 2). By contrast, the public sector participates to the financing of R&D with a share which is among the highest, and second only to Portugal;
- the marginal participation of the industrial sector to the financing of R&D activities is mainly due to the fact that the Italian industrial structure is characterised by a presence of small and micro firms which is higher than the European average. In Europe-19 there are more than 19 million enterprises, among which only about 40.000 (0.2%) are large firms, and the remaining (99.8%) are small and medium enterprises (SMEs) (European Commission, 2004). Within the group of SMEs, the vast majority (over 90 %) are micro enterprises, employing fewer than 10 persons, and approximately half of these micro enterprises have no employees at all. Italy presents a size distribution of firms which is even more skewed towards the small (or micro) dimension (see Table 1). While large firms have a similar share, the overall average size of Italian firms is 4 employees, which is lower than the average European firm size (7 employees).

Figure 1: R&D intensity (% of GDP), latest available year (1)



Notes: (1) D, E, A: 2001; F, FIN, UK, US, JP, and EU-15: 2000; all other countries: 1999. (2) L data are not included in EU-15 average.
Source: European Commission, 2003, *Third European Report on Science & Technology Indicators*, European Commission, Directorate-General for Research, Bruxelles.

Figure 2: Financing of R&D – share (%) of each source of total financing, 1999



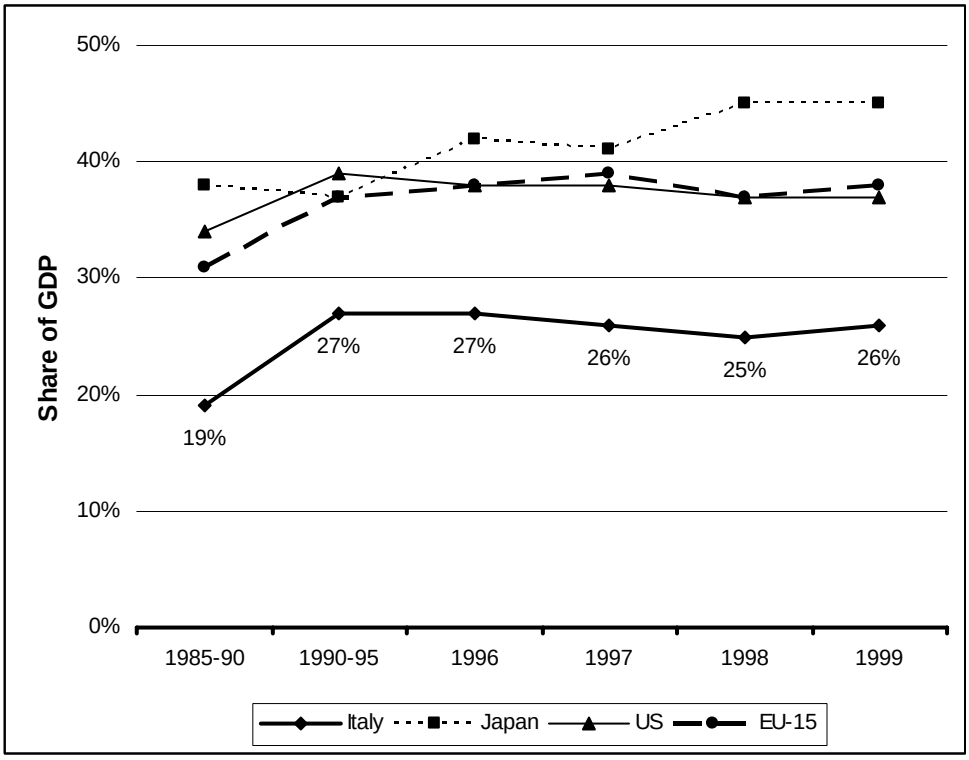
Notes: (1) Data for Italy refer to 1996. (2) L data are not included in EU-15 average.
Source: European Commission, 2003, *Third European Report on Science & Technology Indicators*, European Commission, Directorate-General for Research, Bruxelles.

Table 1: Size distribution of Italian firms (2001)

Employees	Firm type	Nr. of firms		Cumulative %
1	Micro	517,410	47.09%	47.09%
2	Micro	175,504	15.97%	63.06%
3--5	Micro	191,910	17.47%	80.53%
6--9	Micro	90,604	8.25%	88.77%
10--15	Small	57,314	5.22%	93.99%
16--19	Small	18,734	1.70%	95.69%
20--49	Small	33,213	3.02%	98.72%
50--99	Medium	8,367	0.76%	99.48%
100--199	Medium	3,463	0.32%	99.79%
200--249	Medium	596	0.05%	99.85%
250--499	Large	1,026	0.09%	99.94%
500--999	Large	397	0.04%	99.98%
1000 and more	Large	251	0.02%	100.00%
Total		1,098,789	100.00%	

Source: ISTAT, 2001, *National census of industrial firms 2001* – Available at http://193.204.90.17/cis/index.htm.

Figure 3: R&D expenses by universities – share (%) of GDP, 1985-1999



Source: OECD, 2002, *Main Science and Technology Indicators 2001*, OECD.

The interaction of these conditions has created a situation of weakness of the national system of research, which has also had negative consequences on technology transfer activities promoted by the universities. As a matter of fact, only in recent years this topic has become central to the public debate. In turn, Italian universities have only recently started to promote technology transfer activities, and primarily activities directed to an

active management of intellectual property. In the past, the traditional approach towards technology transfer was mainly the result of efforts of individual researchers and professors, who were often able to create connections with the industry without any formal support from their parent organisations (Balconi et al., 2004).

The growing attention posed by MIUR - the Italian Ministry of University and Research -, and by individual universities on the exploitation of research results has resulted in an increasing complexity of the activities promoted to meet such a goal. As it will better exposed in the following sections, it is possible to identify several phases of intervention. In this first phase, the vast majority of Italian TTOs were set up mainly to raise awareness about an IPR culture, somehow encouraging researchers to think at whether patenting the results of their research before going through publications, to think at the patent as an intermediate means required to cooperate with the industry in the short term, but also in long term agreements, to think about the creation of spin-off companies as a preferred solution for bringing the technology embedded into the patent to the market.

Only at a later stage Italian universities have started to think about technology exploitation activities in a more organised and formalised way. They have started to approve specific regulations for the management of IPRs, spin-offs and university-industry collaborations in general. And few of them have set up specialised Technology Transfer Offices, by adopting solutions that partly reproduce those of international best practices, and partly have been adapted to the Italian or even local context. The following sections present a descriptive analysis of these experiences.

In general terms, however, all Italian universities have followed an evolution path that has been very similar across them. It can be summarised in the following phases:

1. **the generation of intellectual property**: the first step of TT process is strongly linked with university basic research, because of its raising up from research developed by university researchers and founded with public founds. The main actor of this phase is the researchers. During the IP generation process it is extremely important to take into account that IP exploitation is possible only if IP generation comes from solid bases and strengthened rights. This means that it is important to have a due IP protection of the research results in order to be able to guarantee a fruitful valorisation in the future. In a first step, it has to be evaluated if a sufficient freedom-to-operate is available. If the commercialisation of research results depends on intellectual property rights – mostly patents – of external parties, it will be much more difficult to exploit the new technology. The researchers responsible for the research group have to be aware of the university policy regarding IP protection, but they have not to be expert in patents and legal issues. University TTO shall provide all the information and help researchers in determining and implementing the appropriate strategy and in negotiate and establish fair collaboration and licensing agreements.
2. **the valorisation of intellectual property**: in this phase the university subscribes technology transfer agreement with industries and obtains commercial results from the research results that have been patented in the IP generation phase. There are three ways to exploit a technology: licensing agreement, spin-off generation and research contract.
    a. **Licensing**: this mechanism transfers commercialisation rights on existing university know-how and results, i.e. the results of the IP-creation phase, to

existing companies by means of a legal agreement. Mostly, it concerns the rights on a patent, a trademark or an industrial design, developed and owned by the university. The researchers are the main players in this process. They have created the IP, which is transferred, and they mostly have a wide network of industrial contacts, which can be used to find possible licensees. Of course, the technology transfer officers have to support the process of finding customers for the university IP. This is especially useful when the IP created by the researchers could also be exploited in application fields outside their normal research scope. The most important role of the technology transfer officers is however to support the researcher in negotiating a fair deal in which pricing and the intellectual property rights are clearly determined.

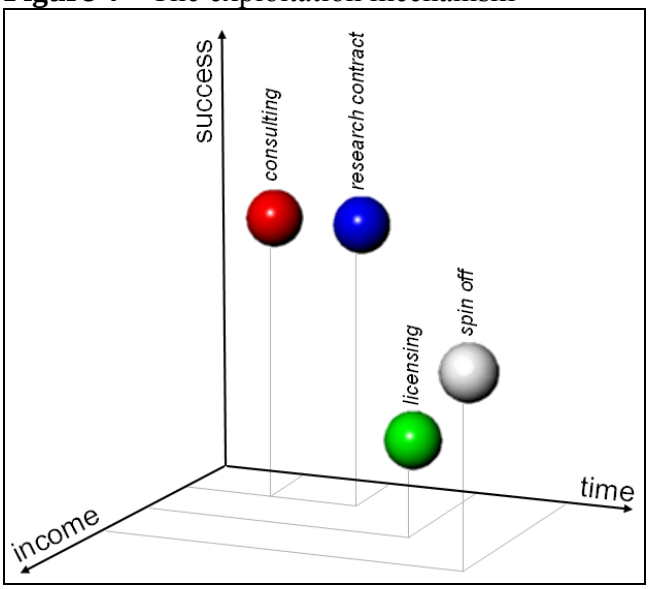
b. **Spin-offs**: this mechanism consists of starting a new company, sharing equity with university, that commercialises existing university know-how and research results. The main reason to establish a spin-off company is the valorisation of research results and the industrial development of new products based on technology owned by the university. In this mechanism the researcher has a key role because he becomes an entrepreneur. It is important to take into account that the researcher is not a manager and for this reason the new spin-off company has to acquire management tasks from outside. Before establishing a new company it is really useful to make a business plan in order to clarify strengths and weaknesses of the project. In this process the role of a TTO is to help the researchers in the drawing up of the business plan and to help the university in the spin-off proposal evaluation phase.

c. **Research Contracts**: This mechanism is based on transferring university know-how and results to an existing company (or a consortium of companies) by setting-up a joint collaboration project based on a specific research field.

3. **Interactions between exploitation mechanisms**: These three valorisation mechanisms do not exclude one each other. Indeed, both research contract and license agreement bring researchers into contact with industry, on the other hand often a spin-off is a university partner for research contracts or license agreements. However, they have different financial consequences. Research contracts and consultancy generates an almost immediate return and is almost risk-free. Research contracts often act as a founding mechanism, which enables investments in patents and spin-offs that only generate a return in longer terms. Licensing is more risky than research contracts, as the major part of the revenues depends on further successful technological and market developments. However, as licensing is done by existing companies, and mostly by big companies, the market risk is sufficiently lower than when starting a spin-off. Nevertheless, spin-offs are an appropriate mechanism to generate high returns (see figure 4).

It is clear that the main goal of a technology transfer office is to guide the research groups in establishing an appropriate exploitation strategy. That means the definition of a strategy in the management of intellectual property, supporting negotiations with industries and helping in the management of the legal and contractual aspects.

Figure 4 – The exploitation mechanism



3. The survey about the valorisation of research results in Italian universities

3.1 Methodology

In order to explore the specific efforts recently made by Italian universities in protecting and transferring the results of their research activities, we submitted to the Technology Transfer Offices (TTOs) of such institutions a questionnaire for two consecutive years[2]. More precisely, during the first months of 2003 a questionnaire was sent to Italian universities which was very similar to one used in the UK in a survey organised by Unico together with the University of Nottingham; the following year, during the first month of 2004, a slightly modified questionnaire (attachment n.1) was sent which was very similar to the one used by the *Proton Network* (www.protoneurope.org), which started a European survey to which the *Network Universitario per la Valorizzazione della Ricerca*[3] participated as the Italian partner.

The questionnaires – particularly the first one – included both quantitative and qualitative questions, and aimed at exploring the human and financial resources devoted to the activities of technology transfer, the results obtained (number and characteristics of patents granted, number and characteristics of licenses concluded, number and characteristics of spin-off companies created, and so on), the motivations to promote such activities, and the obstacles that the TTOs had to face.

The questionnaires have been submitted through email to all Italian universities. Likely potential respondents were identified and contacted to confirm receipt of the

[2] The research was carried out by the authors on behalf of the *Network per la Valorizzazione della Ricerca Universitaria* (University Network for Research Valorisation), a network established in 2002 to which most Italian universities now take part in order to discuss and exchange experiences regarding the valorisation of research activities. Information about the Network and annual reports are available at www.netval.it.
[3] See http://www.netval.it.

questionnaires and a dialogue was maintained to ensure progress was being made in completing the questionnaires. The survey has been facilitated by the fact that most respondents are members of the already mentioned Network and consider the final results as a benchmarking exercise which could provide useful information for their activities. The procedures adopted made it possible to identify appropriate respondents with accuracy and to reduce delays in obtaining information. Furthermore, the institutions surveyed were asked to provide their best estimate for each question if an exact response was not known.

In table 2 the situation of universities which have answered to the questionnaire 2003 is presented. In total, 29 universities answered the 2002 survey, and 26 the 2003 survey. These latter represent 56% of total Italian university students.

Table 2 – Number of student enrolled and number of professors of universities responding to the 2003 survey

	University	***Nr. Students enrolled in Academic Year 2003-2004****	***Share of National Total***	***Cumulative Share***	***Nr. Students attending on Dec. 31st, 2003***	***Share of National Total***	***Cumulative Share***
1	Università "La Sapienza" di Roma	135,639	7.52%	7.52%	4,718	8.39%	8.39%
2	Università di Bologna	96,836	5.37%	12.89%	2,968	5.28%	13.67%
3	Università di Milano	62,855	3.49%	16.38%	2,270	4.04%	17.71%
4	Università di Torino	61,998	3.44%	19.82%	2,019	3.59%	21.30%
5	Università di Firenze	61,104	3.39%	23.21%	2,265	4.03%	25.33%
6	Università di Padova	59,300	3.29%	26.50%	2,119	3.77%	29.10%
7	Università di Pisa	49,029	2.72%	29.22%	1,826	3.25%	32.35%
8	Politecnico di Milano	39,268	2.18%	31.40%	875	1.56%	33.91%
9	Università di Cagliari	38,511	2.14%	33.54%	1,273	2.26%	36.17%
10	Università di Parma	29,853	1.66%	35.20%	1,046	1.86%	38.03%
11	Università "Tor Vergata" di Roma	29,479	1.63%	36.83%	1,244	2.21%	40.24%
12	Università di Lecce	29,335	1.63%	38.46%	650	1.16%	41.40%
13	Università della Calabria	28,767	1.60%	40.06%	590	1.05%	42.45%
14	Politecnico di Torino	24,182	1.34%	41.40%	765	1.36%	43.81%
15	Università di Pavia	22,390	1.24%	42.64%	1,124	2.00%	45.81%
16	Università di Siena	18,568	1.03%	43.67%	970	1.73%	47.54%
17	Università di Genova	17,251	0.96%	44.63%	1,633	2.90%	50.44%
18	Università di Udine	16,772	0.93%	45.56%	648	1.15%	51.59%
19	Università di Ferrara	16,122	0.89%	46.45%	668	1.19%	52.78%
20	Università di Modena e Reggio	12,659	0.70%	47.15%	723	1.29%	54.07%
21	Università di Foggia	10,100	0.56%	47.71%	209	0.37%	54.44%
22	Università del Piemonte Orientale	10,004	0.55%	48.26%	320	0.57%	55.01%
23	Università di Camerino	9,230	0.51%	48.77%	151	0.27%	55.28%
24	Università dell'Insubria	8,149	0.45%	49.22%	306	0.54%	55.82%
25	Scuola Superiore Sant'Anna	-**	-	-	51	0.09%	55.91%
26	SISSA di Trieste	-***	-	-	53	0.09%	56.00%
Totale		***887,401***	***49.22%***	---	***31,484***	***56.00%***	---
National Total		***1,803,024***	***100%***		***56,226***	***100%***	

3.2 Results

As expected, one of the first results of the survey is that the commercialisation of research results is a rather recent phenomenon in Italy. Most universities have created a small

group or team devoted to technology transfer only in the last 3-4 years (table 3). The first institution which formally created a TTO is the University of Bologna, which launched this kind of activity in 1989. In some cases, universities have promoted technology transfer in the past, with some results, but without a deliberate effort or policy (or the setting up of a specific administrative unit). Only recently they have devoted full time executives and support staff to this task.

Table 3 – Starting year of technology transfer activities

Fiscal Year	Number of universities	Fiscal Year	Number of universities
1989	1	1997	1
1990	0	1998	2
1991	0	1999	0
1992	0	2000	2
1993	0	2001	8
1994	0	2002	8
1995	1	2003	4
1996	0	**Total**	**27**

The offices which currently exist are usually small in size, employing no more than five employees (the average being 4.3 people – see table 4). In some cases, some of the employees have specialised responsibilities and tasks, and are dedicated either to the commercialisation activities or to the promotion of technology licenses and the management of intellectual property rights. In some other cases, probably because of the small size of the office, the personnel has no specific responsibilities, and all the employees together are engaged in the various activities, according to specific needs. As table 4 shows, the average size of TTOs has significantly grown during the last year. In 2002 most universities had no more than 2 employees engaged in activities of research valorisation, and no one had an office with more than 4 employees. By contrast, in 2003 many TTOs have increased their size, and few of them have employed even more than 10 employees.

Table 4 – Size distribution of TTOs (People employed in terms of Full Time Equivalents – FTEs)

Number of full time equivalents (FTEs)	Number of universities	
	Fiscal year 2003 (N = 16)	Fiscal year 2002 (N = 27)
0	1	4
0 – 1	4	8
1 – 2	1	10
2 – 3	4	3
3 – 4	1	2
4 – 5	0	0
5 – 6	1	0
6 – 7	0	0
7 – 10	2	0
≥ 10	2	0
Total	69.5	42.8
Average	4.3	1.6

As recalled above, one of the main motivations that have led to the establishment of technology transfer offices within universities is the protection of research results through patents. Accordingly, services devoted to the protection of intellectual property are the first activity that TTOs usually provide. This is confirmed by the results of our survey as well. As table 5 shows, patenting is widely diffused among Italian universities, even though with some differences among them. First, although almost all universities have applied for Italian patents at least once, only a smaller share of them have applied for patents at either the European or the US patent offices. Second, only a marginal fraction of universities has an overall number of patent applications – independently from the patent office they have applied to – higher than 10 to 15 applications per year. Nevertheless, most universities have increased their attention to patenting during the last year, and indeed the average number of patents per institutions has increased from 2002 to 2003.

This result is reflected in the resources that universities devote to the protection of intellectual property. As table 6 demonstrates, out of 26 universities which answered this specific question, only 6 have not spent any money in patent protection. On the contrary, all other universities have spent up to almost € 600K in 2002. These expenditures include costs for legal fees, patent costs, consultancy and specialist IP advice. The average amount that institutions spent on external fees to protect their IP has been € 26.1K.

Table 5 – Patent applications by Italian universities

Number of patent applications	**Number of universities**					
	Italian patent applications		**USPTO patent applications**		**EPO patent applications**	
	F.Y. 2003 (N = 19)	**F.Y. 2002 (N = 23)**	**F.Y. 2003 (N = 13)**	**F.Y. 2002 (N = 17)**	**F.Y. 2003 (N = 16)**	**F.Y. 2002 (N = 17)**
0	1	6	7	11	5	9
1-5	10	11	5	5	10	6
6-10	6	3	0	1	0	1
11-15	1	2	1	0	1	1
16-20	1	0	0	0	0	0
21-25	0	0	0	0	0	0
26-30	0	0	0	0	0	0
31-35	0	1	0	0	0	0
≥ 35	0	0	0	0	0	0
Total	**99**	**110**	**23**	**18**	**39**	**31**
Average	**5.2**	**4.8**	**1.8**	**1.1**	**2.4**	**1.8**

Table 6 – IP protection expenditures by Italian universities in 2002 and 2003

Expenses	Number of universities	
	Fiscal Year 2002 (N=26)	Fiscal Year 2003 (N=20)
0 €	6	0
0 – 15 K €	5	8
15 K € – 30 K €	6	3
30 K € – 45 K €	6	4
45 K € – 60 K €	0	1
60 K € – 80 K €	2	0
≥ 80 k €	1	4
Total	599,720 €	802,760 €
Average	23,066 €	40,138 €

Despite these resources devoted to IP protection, which demonstrate university willingness to promote research commercialisation, only a few institutions were actually able to sell their research results. During 2002, only ten institutions (out of 25 that answered these questions) executed at least one license or option (table 7), only two of which included an equity component, i.e. the institution received shares in the company which a licence was granted to as a royalty payment or as part payment of the licence being granted. In 2003 the number of licenses and options executed has significantly grown, both because the number of institutions signing at least one contract has increased, and because the average number of contracts per institution has increased as well (from 1.08 to 2.29). Similarly, the overall amount of licensing income has increased from 2002 to 2003, but only because a few universities have signed contracts of higher unit value (table 8).

Table 7 – Number of licenses or options executed in 2002 and in 2003 by Italian universities

Number of licenses or options executed	Fiscal Year 2002: number of universities (N=25)	Fiscal Year 2003: number of universities (N=17)
0	16	5
1	2	3
2	3	4
3	2	1
4	0	1
5	1	1
6	0	1
7	0	0
8	1	0
9	0	0
≥ 10	0	1
Total	27	39
Average	1.08	2.29

Table 8 – License income generated in 2002 and in 2003 by Italian universities

License income generated	**Fiscal year 2002: number of universities (N=27)**	**Fiscal year 2003: number of Universities (N=13)**
0€	18	7
0-20k€	1	3
20-40k€	4	0
40-60k€	3	0
60-80k€	0	0
80-100k€	1	1
100-120k€	0	0
120-140k€	0	0
140-160k€	0	0
160-180k€	0	1
180-200k€	0	0
>200k€	0	1
Total	364.5 €	610,110 €
Average	13.5 €	46,932 €

These results clearly show that the possibility to earn additional income does not represent the main outcome of technology transfer activities promoted by universities. At least at present, in most cases, financial returns generated by licenses (in terms of royalties or fixed fees) do not even cover the expenditures incurred for the protection of intellectual property. If indirect costs, such as personnel costs or the costs for running the offices, were also included, this situation would dramatically worsen. As a matter of fact, as it has been demonstrated by the experience of American universities, technology transfer represents a valuable source of financial resources to the universities only in rare cases, i.e. when some breakthrough technologies are developed and industrial applications are immediately available. But this represents such a risky and uncertain event that in most cases universities only earn small flows of resources.

Nonetheless, the possibility to generate additional funds for the university and specific departments, to be devoted to research activities, does represent the main institutional goal that university officers declared to pursue (in our survey) with technology transfer[4]. Other goals, such as generating knowledge spillovers for the economy, both at the local and national level, are also indicated. In some cases, universities promote the commercialisation of research results in order to gain revenues for the researchers themselves and to the academic staff (table 9). And, indeed, almost every university regulation concerning intellectual property rights and patents defines the share of (potential) revenues which have to be allocated to the inventors (Baldini, Grimaldi and Sobrero, 2005).

[4] In our experience, this same objective is not indicated as the most important when TTO managers are involved in informal talks or in workshops, and the objective of contributing to regional and national economic development is growing in importance.

Table 9 – Institutional goals of technology transfer activities (answers provided in 2003) in Italian universities.

Goals (1 = Most important; 4 = Least important)	**Average value**
To generate additional funds to university and departments	1.20
To generate revenues to academic staff	2.42
To generate spillovers to the local economy	2.44
To generate spillovers to the national economy	2.52

In our view, on the whole, these results are a sort of an indicator of the stage of the "life cycle" at which Italian TTOs are currently placed. As discussed above, most of them are very young, and have started to actively promote the commercialisation of research results only recently. We could argue that they are in the introduction phase of their life cycle. They are building up the experience and competence which are necessary to effectively evaluate the difficulties in marketing new technologies, and in stimulating a demand for research outputs, but they surely have enthusiasm and interest in the topic. Sometimes this interest comes from the "head" of the university, and in other cases it comes from single professors or middle level university managers who try and start this kind of activity despite weak motivations from top university managers and leading professors. As a matter of fact, a large part of the TTOs analysed in the survey have been created as a consequence of the growing attention and public discussion about the valorisation of scientific research that has taken place in Italy during the last years. Accordingly, most TTOs managers place much emphasis on their activity and often tend to overestimate their current and expected results. At the same time, we have to acknowledge a genuine interest in these activities, which are new for many universities, by a relevant number of managers and professors, who actively experiment and exchange practices, and try and find concrete and effective ways to manage protection and commercialisation issues, often experimenting new contractual forms with leading firms.

Only at a later stage of their life cycle, when more experience will be accumulated, and effective obstacles and opportunities will be correctly assessed, "correct" expectations can be formulated. It is also worth noting that this situation can represent a favourable solution of the current debate about the role of universities. In fact, those people who are contrasting a more entrepreneurial role of universities in modern economies can find in these results a rather positive solution. More precisely, as is seems, no radical changes in the university mission are likely to take place. Rather, if the possibility to obtain huge profits is not feasible (as most empirical evidence shows), the real effects of efforts in technology commercialisation made by universities will be to increase the diffusion of university knowledge and technologies, and to generate positive spillovers for the economy. In other words, we argue – although further analyses at international level are certainly needed - that all this may well happen without negative influences on the "fundamentals" of the university systems in terms of choice of research topics, independence, orientation towards the diffusion of research results.

One of the means through which universities can facilitate the diffusion of knowledge is the creation of new technology-based spin-offs. The formation of these new companies is largely dependent upon technologies generated within the parent organisations. Hence, by supporting the creation of a spin-off, universities not only attribute a value to their technological competencies and efforts, but they also contribute to the economic

development of local economies. Furthermore, they favour an increase in the local employment rate of skilled and qualified workers. All these purposes seem largely desirable from a social point of view.

In order to meet this goal, many universities have developed internal facilities (such as business incubators or science parks) specifically devoted to the creation of new ventures. Among respondents to our survey, in 2002, 35.7% have declared to have a business incubator, and 45.5% (in 2003, 64%) are taking part to a science park. In turn, many universities have supported the formation of new firms.

As table 10 shows, in 2002 three universities had generated one spin-off company each, and nine universities had supported the creation of 14 start-ups on the whole.[5] In 2003, the overall number of spin-offs and start-ups has significantly grown, reaching the number of 31 and 26, respectively. On the whole, however, the stock of spin-offs created by Italian universities during the last years is rather high. For example, the University of Bologna and Scuola Superiore Sant'Anna in Pisa have a spin-off portfolio of about 15 firms, and other universities have obtained similar results (Cesaroni, Moscara and Piccaluga, 2004).

These results clearly suggest that the creation of new technology-based firms is a critical component of the strategy of research valorisation pursued by Italian universities. As a partial demonstration of the considerations expressed above concerning the real motivations of Italian universities to contribute to the diffusion of technological knowledge rather than to an increase of revenues (research funds), it is worth noting that, in many cases, the efforts directed towards the activity of spin-off creation are even higher than the human and financial resources devoted to the commercialisation of (patented) technologies through licensing.

Table 10 – Spin-offs and start-ups from Italian universities

[5] Spin-offs differ from start-ups, because in the former there has been a formal transfer of technologies from the university to the new venture (e.g. a patent license), while the latter are new ventures whose creation has been supported by the university, but which not consisted in a technology transferred from the parent company to the new venture.

Number of universities having:	Number of firms									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**≥ 6**	**Tot**	**Avg.**
Spin-offs created in 2002	18	3	0	0	0	0	0	0	3	0.1
Spin-offs created in 2003	8	5	1	0	2	2	1	0	31	1.6
Existing spin-offs created before 2003	8	4	1	1	1	0	0	4	52	2.7
Spin-offs localised in the same university region in 2002	14	6	1	2	1	0	0	1	28	1.6
Spin-offs localised in the same university region in 2003	4	6	3	0	1	0	1	4	60	3.2
Spin-offs that failed in 2003	15	0	0	0	0	0	0	0	0	0
Spin-offs in which the university holds an equity (directly or through a related seed fund) in 2002	18	6	0	0	0	0	0	1	16	0.6
Spin-offs in which the university holds an equity (directly or through a related seed fund) in 2003	7	5	2	0	0	2	0	0	19	1.2
Start-ups created in 2002, and NOT based on a license of IPR generated by the university	14	7	0	1	1	0	0	0	14	0.6
Start-ups created in 2003, and NOT based on a license of IPR generated by the university	8	2	1	2	0	1	0	1	26	1.7
Start-ups having received a support by the university TTO	8	1	1	1	0	2	1	0	22	1.6

4. Representative examples of Italian TTOs

In general terms, several types of university TTOs exist in Italy. One possible taxonomy in based on the age and size of the TTOs. A few TTOs are more consolidated in terms of mission, management practices, human resources; the majority is relatively young, and has clear missions and dynamic, albeit limited in number, professionals, wo work with the support of enthusiastic academics. A third group is formed by a relevant number of TTOs which are at the very early stage of their activity, and can count on little more that a formal commitment by their university: the project for a TTO has been formalised and human economic resources are being put together.

Another way at looking at TTOs is analysing the emphasis they put on the various types of activities (namely patenting and licensing, spin-offs and – more recently - contract research), which is closely linked with the way the universities interpret their role at local and regional level. It is quite evident, for example, that small/emerging universities in less developed areas will have different objectives from large universities in metropolitan areas. However, the variety of possible strategic choices for universities is rather large.

In order to better describe and characterise the universe of Italian TTOs, and to appreciate the differences existing among them, in this section we present two (rather extreme) case studies of current experiences: the case of Milan Polytechnic and that of the University of Calabria.

As suggested by the discussion of the previous sections, the motivations behind the creation of a TTO, and the way in which it is organised and operates are affected by the influence they receive from the local environment in which they are placed. It is likely to suppose that universities localised in particularly dynamic regions characterised by an

articulated industrial context will receive more (and more complex) stimuli, and will respond to these stimuli by offering a more multifaceted set of solutions. It is reasonable to expect that all the different means of technology commercialisation – from consultancy to contracts, and from licensing to spin-off creation – will be used according to specific needs. The demand expressed by the industrial counterpart represents in this case a strong determinant of TTO's activity. The experience of Milan Polytechnic represents a significant case in point.

By contrast, universities localised in less developed regions, in which the industrial context is less articulated, and the social pressure to an active intervention of the university to the local economy is higher, will be more oriented to promote activities that might have a stronger impact in the local economy. Most likely, this goal will be translated into a higher effort in creating new technology-based companies, which often are considered a preferred solution to induce economic development and growth in marginal regions. Rather than responding to stimuli coming from the industrial counterpart, the university aims at stimulating the economic environment from the (research) supply side. Clearly, the lack of conditions at the demand side will potentially reduce the effectiveness of such a policy, and overall results might eventually be lower than expected. Nevertheless, the main motivation of the university remains clearly defined. University of Calabria is an interesting example of this case of TTO.

4.1 The case of Milan Polytechnic

Milan Polytechnic (*Politecnico di Milano*) is one of the most important Italian universities, both for its size and its specialisation in engineering studies. Its activities in research and education, as well as those regarding technology transfer have to be contextualised within a metropolitan and regional area which is well known for its advanced industries, a dynamic network of manufacturing companies, as well as offices and plant od several multinational companies.
Milan Polytechnic (MP) has been one of the first universities in Italy to perceive the importance of technology transfer issues and to establish an internal office dedicated to IPR management. During the 1998-2000 period MP was involved in the NEICO European project, whose main purpose was to write a feasibility study for the implementation of an IPR dedicated structure within the university. Thanks to this project, it was possible to persuade the university main board to establish a structure dedicated to technology transfer activities. The first structure supporting researchers in patent filing activity has been set up in 1999. This first service was enlarged in 2001 with the creation of a "Patent Service" within a university structure not dedicated to technology transfer. In this phase the university board approved some university policies regarding university IP strategy and establish some procedures to manage the researchers' requests. Finally, in 2002, the Technology Transfer Office was established as a technology transfer dedicated structure within the university.

Following the creation of the TTO, several other activities have been started: a permanent training workshop programme on IPR issues and then a valorisation activity based on patent licensing and spin-off generation. In general terms, the evolution of Milan Polytechnic's TTO has followed four steps:

1. patent culture;

2. patent request evaluation and spin-off creation;
3. database of research activities and of agreement with industries;
4. study of all the possible ways to protect intellectual property (patents, copyrights, industrial design, and trademarks).

First of all it has been important to start creating an IP culture within the university and to establish regulations and procedures to allow a quick university patenting activity that doesn't inhibit or delay the publication of research results. For this purpose, a functional model was implemented, allowing to obtain a decision regarding the national filing of a patent within 45 days from the researcher's request.

During the first and the second step of the evolution of the TTO, a lot of efforts were put on the evaluation process, but also on the implementation of licensing activity, strategy definition and establishment of rules, procedures and tools to foster the university spin-off generation.

The third step represents the "bet" for the future, since it requires to solve some weaknesses of the university technology transfer process:

1. **research monitoring**: the refusal rate of patent requests (due to lack of novelty) is still too high. The communication activity has to be increased within the university and on the other hand have visibility on the research projects developed by the different research group in order to prevent pre-publication;
2. **agreement with industries**: there is still a cultural gap to fill between university and industrial world. due to this gap there are delays and difficulties in reaching agreements. New standard contracts have to be set up for licensing agreements and research activity;
3. **creation of a new figure, the TTO manager**: it seems important that this profession is recognised by university board because the TTO manager is nor clerical neither academic staff and, at the moment, he/she does not have a clear position within the university organisation.

Finally, the motivation for the fourth step is to provide a complete service pack for the researchers about IP protection. For this reason, the TTO staff is making efforts to acquire skills about trademarks, industrial design, utility models and software.

It is quite evident that the activities of MP in the field of valorisation of research have had the objective of introducing in the university a new service which is gradually becoming a normal feature of modern universities. Today, internal researchers and professors as well as external companies can count on the TTO as a valuable partner for their activities. At the same time, the TTO is particularly active in establishing IPRs on research results and making them useful industrial applications. From this point of view, the TTO – and the university as a whole – is less interested in starting large numbers of low growth spin-off companies, and more interested in starting a few very promising companies, based on MP's IPR.

4.2 The case of University of Calabria

The case of the TTO in the University of Calabria (UniCal), in the city of Cosenza, in Calabria, in the South of Italy, is rather different from the previous one. Calabria is region characterised by a less developed industrial context, with an economy which is historically based on agriculture. Most industrial initiatives set up during the last few decades have been set up and supported by the central government, and private entrepreneurship has always played a marginal role. Within this framework, UniCal is a young and dynamic university which aims at creating a discontinuity in the traditional development and cultural pattern. Within this mission, the university has tried to stimulate the local economy with relevant research activities in science and technology and by promoting an active technology transfer process. Besides standard initiatives devoted to offer technological solutions to local firms (mainly micro or small firms), the main focus of the technology transfer initiatives is directed towards the creation of new technology-based small companies, which should locate close to the city of Cosenza and therefore create a sort of a cluster of small high-tech firms. In the vision of UniCal's managers, this project offers two related advantages. On the one hand, it positively contributes to the dynamism of the local economy, and might eventually result in an enhanced capacity of the Region to attract external (foreign) firms. On the other hand, the possibility to start a new company, and to transform the results of research activities into a business initiative represents an interesting opportunity for local researchers, which might contribute to reduce the dangerous brain drain that traditionally affects marginal regions like Calabria.

According to this main mission, a **Liaison Office** has been created in 2003, with the following specific goals:

i) to favour the broad diffusion of research results and an extensive deployment of technological resources of the UniCal;
ii) to support initiatives of the University for the protection of intellectual property rights, and for the creation of new spin-off firms;
iii) to promote the participation of UniCal to innovative programs with a local impact, by favouring at the same time the participation of other players of the regional system, such as public and private research centres, local firms, public authorities and institutions, and so on.

Two years after its formal constitution, the activity of the Office is carried out by fifteen persons, some of which are internal employees, and others are external consultants. Among the activities implemented so far, those related to the development of an active networking with the local environment, and those related to the creation of spin-off companies are the most relevant. Concerning the former, the TTO's main objective is to ease the establishment of a collaborative network between local firms and local research institutions. Most of this activity is based on the diffusion of a culture of collaboration among players which are traditionally reluctant to co-operate. Diffusion of information – through newsletters, workshops, meetings, and so on – and exploitation of actual (latent) demand of innovation – through firms auditing and in-site visits – are the main instruments used for this purpose. Table 11 offers a quantitative representation of these activities.

Table 11 – University of Calabria's networking activity (2002-2004)

In-site visits	**60** SMEs visited in 2002, **20** in 2003, and **20** in 2004
Auditing	**50** firms supported
Development of industrial research projects	**16** projects prepared (corresponding to a total budget of € 3.3 million) to apply to regional or national funding programmes

Concerning the activities directed towards the creation of spin-off firms, the first two years of activity of the TTO have been spent to define the legislative and operational instruments needed to perform this task. Specifically, the definition of a university regulation on "university spin-offs" and the kind of support that the university is willing to offer to such a category of firms, and the establishment of agreements with regional and national institutions for the provision of specific services have represented the University's main efforts. Furthermore, by means of a collaboration with the National Institute for the Physics of the Matter (INFM – *Istituto Nazionale per la Fisica della Materia*) few spin-off companies have actually been created, and other business plans and projects of new ventures have been developed. However, by leveraging the experiences of these two last years, the Liaison Office aims at consolidating and enhancing the activities promoted so far. Along this line, in 2005 a project for the creation of a Business Incubator has been approved, and a new University Technological Pole should be launched in the near future.

5. Conclusions

The analyses presented in this study confirm that the process of technology transfer requires a wide and articulated effort, because different visions and objectives about scientific research and industrial needs have to be integrated. Hence, those initiatives that in academia include and integrate both more "codified" ways of transfer – such as patents and their licensing – and more "tacit" ways – such as new firms incubation and consultancy – show extremely interesting potentialities.

From a theoretical point of view, codified ways of technology transfer represent a more efficient mean to attribute economic value to university knowledge portfolio (Arora and Gambardella, 1994). However, we argue that solutions that only aim at the valorisation of patent portfolios will not be as successful as those which *also* promote the valorisation of non-patented (and/or non patentable) knowledge portfolio. The licensing of patented technologies can be usefully complemented by the creation of new spin-off companies. Such an integrated and comprehensive strategy can be considered a sort of an evolution of modes of diffusion of knowledge from universities to industrial firms that historically have been based on the formation of new human resources to be engaged in existing business initiatives. In fact, the birth - and possibly also the growth - of new technology-based firms represents two interesting elements of novelty.

First, such firms represent a possible solutions to the problems of information asymmetries which often characterise technology transfer opportunities. Indeed, if the researcher himself becomes the main user of the knowledge he/she has developed, he/she will be perfectly able to identify all the possible uses of that technology. The tacit component of the technology will be completely exploited in this case, avoiding the risk

that a certain piece of technology is not fully understood by a potential user, both in technical and in commercial terms.

Second, the formation of new knowledge-based ventures is a much more socially accepted mission for universities. By promoting the formation of such firms, universities can directly stimulate the local and national economy. Furthermore, young researchers can be employed in these firms, thus creating positive feedbacks for the economy, not only in fully developed metropolitan areas, but also in emerging or and less developed regions. All this increases the social role of universities.

Clearly, in pursuing both the strategy of technology licensing, and that of spin-off creation, within a comprehensive strategy of valorisation of research results, universities have to develop adequate competencies and to acquire specific organisational and financial resources. As a consequence, long-term plans have to be promoted. In the transition towards the next phase of the already mentioned life cycle of TTOs, an intermediate solution that Italian universities have effectively promoted has been the formation of a network among institutions aimed at the diffusion of experiences and best practices. This is key element for universities in order to appreciate that the objective of commercialisation of research results oblige them to learn new methodologies and "rules of the game" which surely are common characters in the culture of private firms, rather that in public institutions. As a matter of fact, the degree to which private firms will be able to understand, to creatively adapt and to extract benefits from this kind of evolution in university strategies will represent a key issue in making the valorisation of research results a success story or alternatively a disappointed expectation in national innovation systems.

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